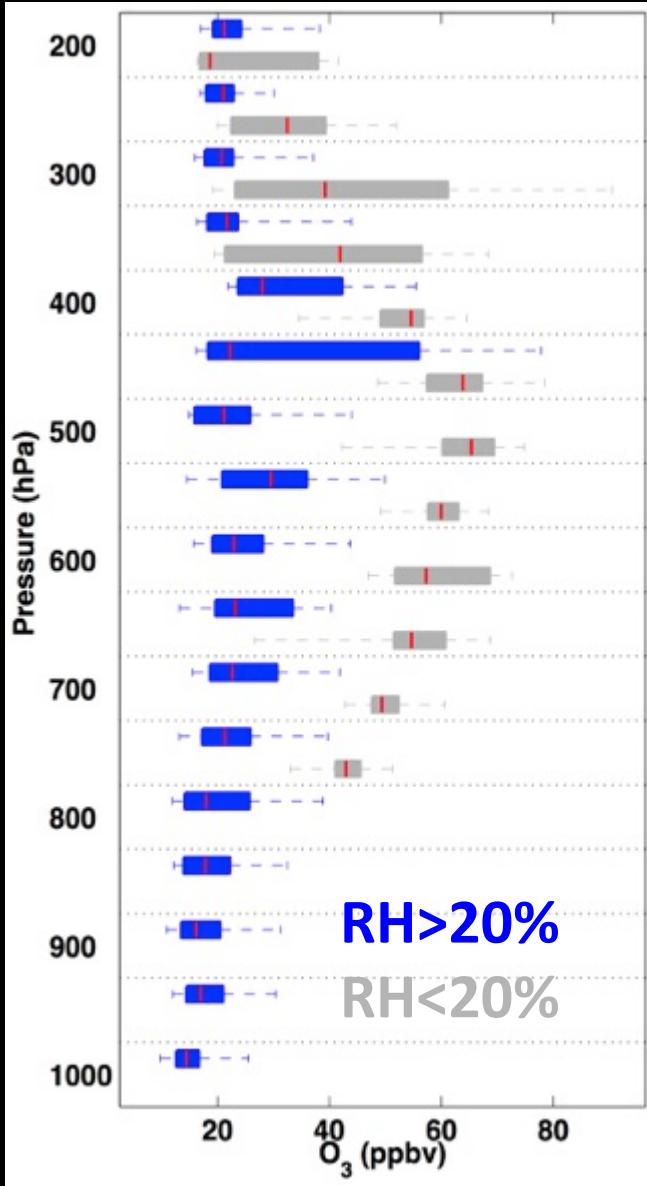


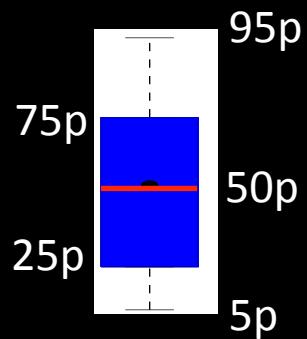
# A Tropical Tropospheric Source of High Ozone/Low Water Filaments in the Western Pacific

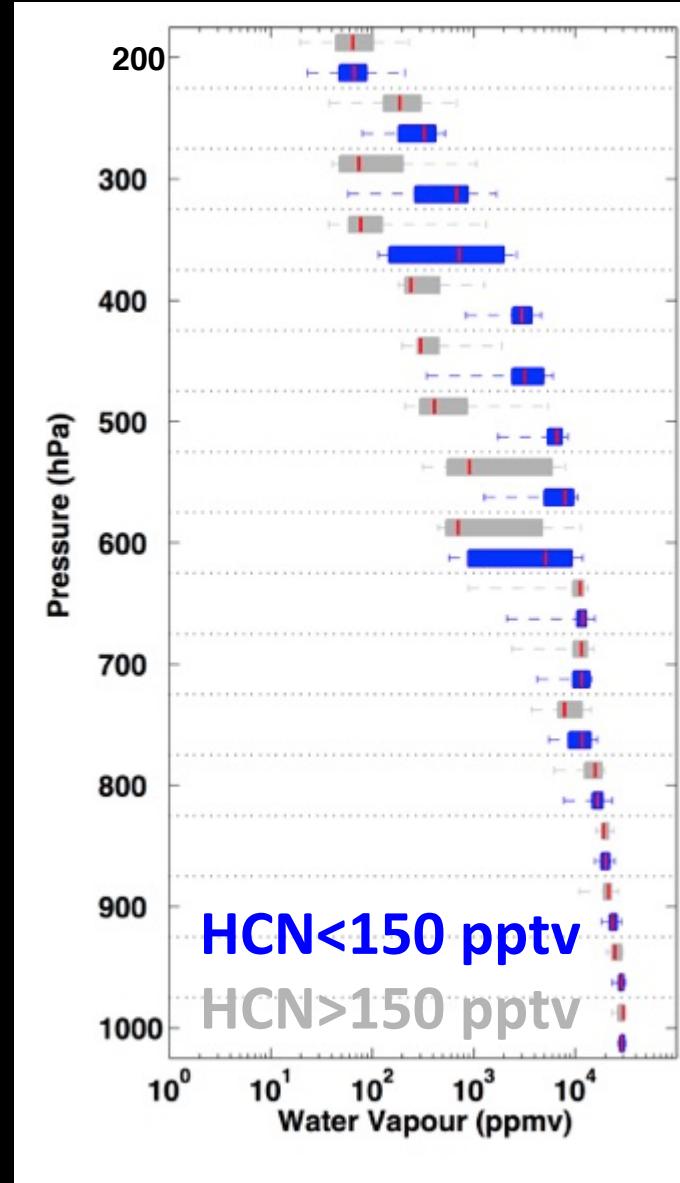
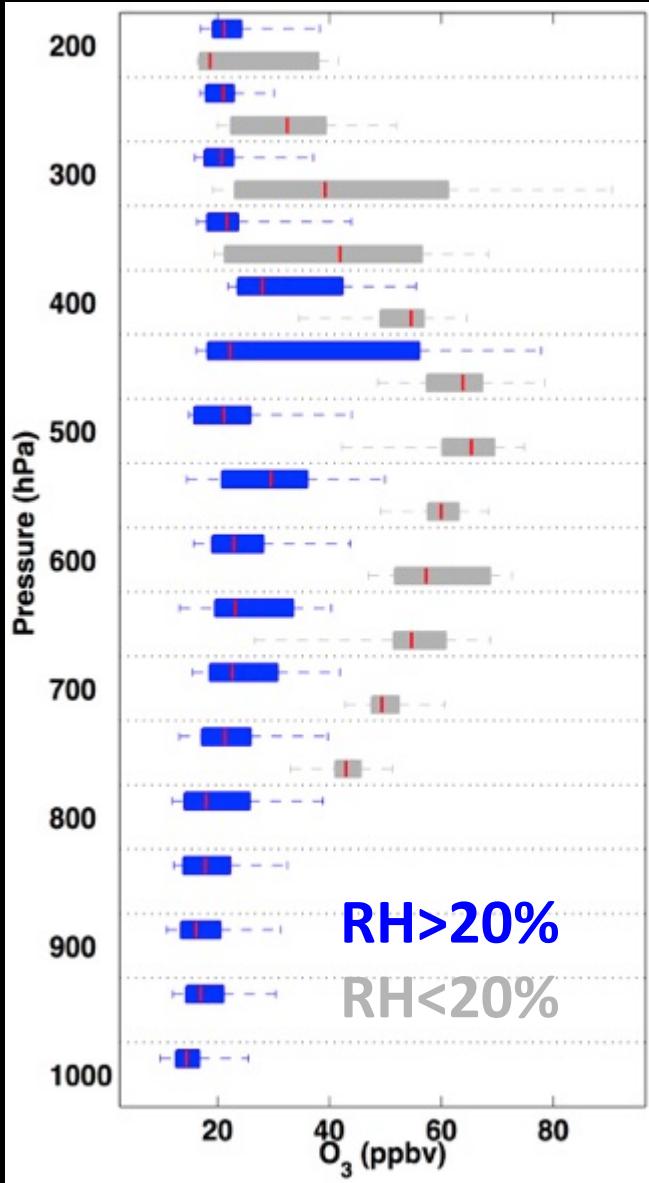
CT3LS Meeting, 22 July 2013

**Dan Anderson, Julie Nicely, Ross Salawitch, Tim Canty, Russ Dickerson, Tom Hanisco, Glenn Wolfe, Eric Apel, Elliot Atlas, Thomas Bannan, Stephane Bauguitte, Nicola Blake, Jim Bresch, Teresa Campos, Lucy Carpenter, Mark Cohen, Mat Evans, Rafael Fernandez, Brian Kahn, Doug Kinnison, Sam Hall, Neil Harris, Becky Hornbrook, Jean-Francois Lamarque, Michael Le Breton, James Lee, Carl Percival, Lenny Pfister, Brad Pierce, Dan Riemer, Alfonso Saiz-Lopez, Anne Thompson, Kirk Ullmann, Adam Vaughan, Andy Weinheimer**



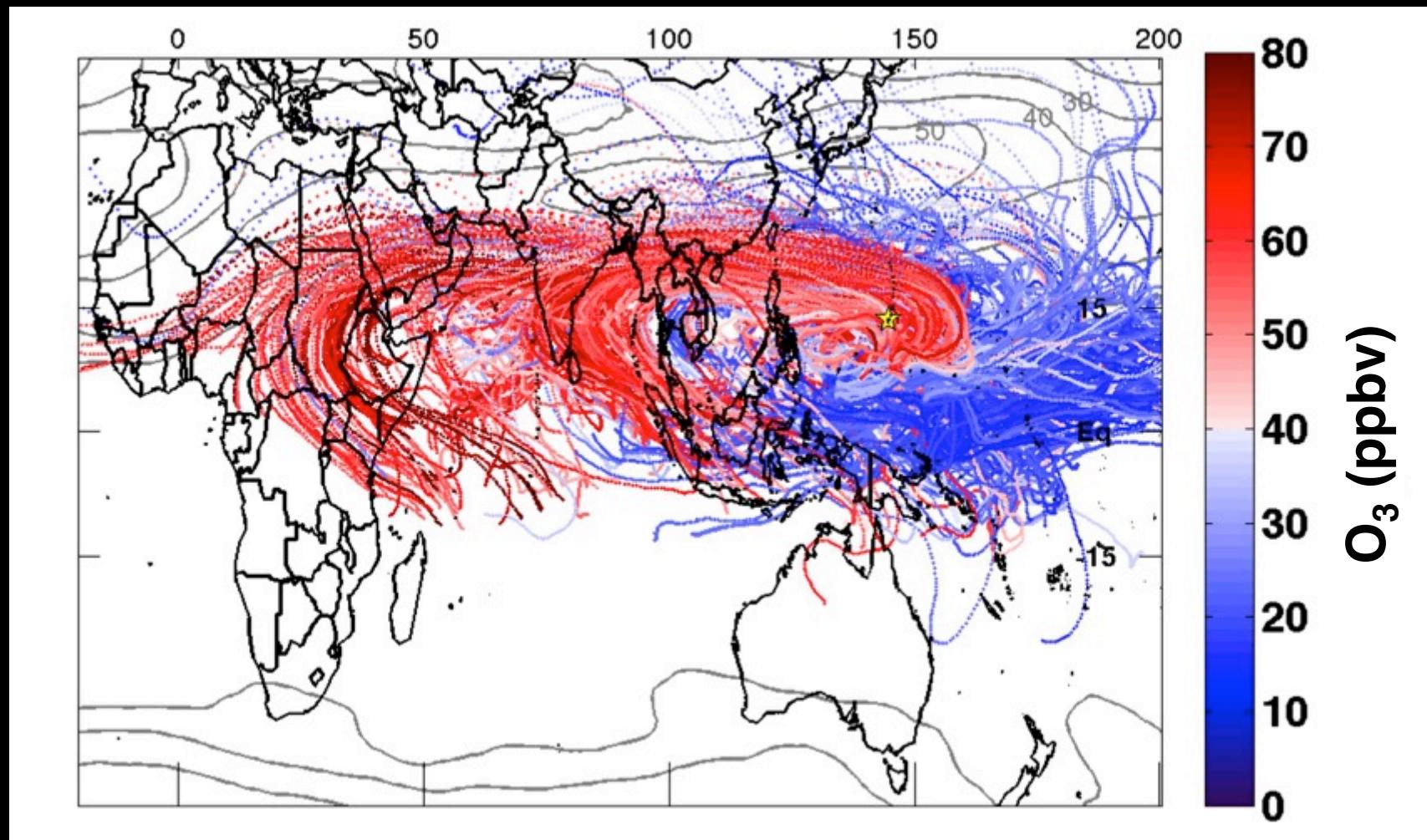
What is the source of the high  $O_3$  ( $O_3 > 40$  ppbv) and low water (RH < 20%) filaments?



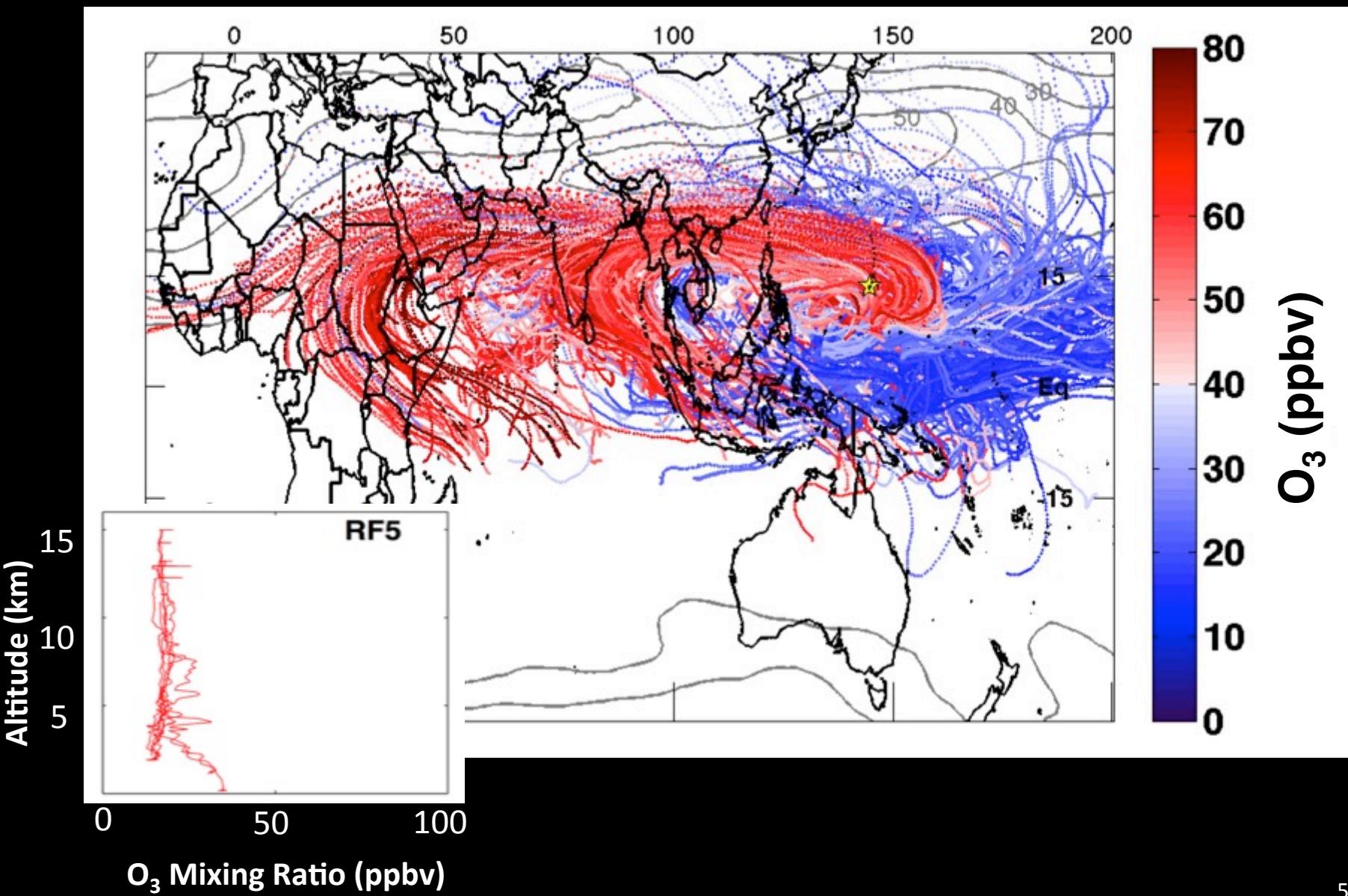


*In situ* observations, satellite data, and model results suggest biomass burning and large-scale descent in the tropics.

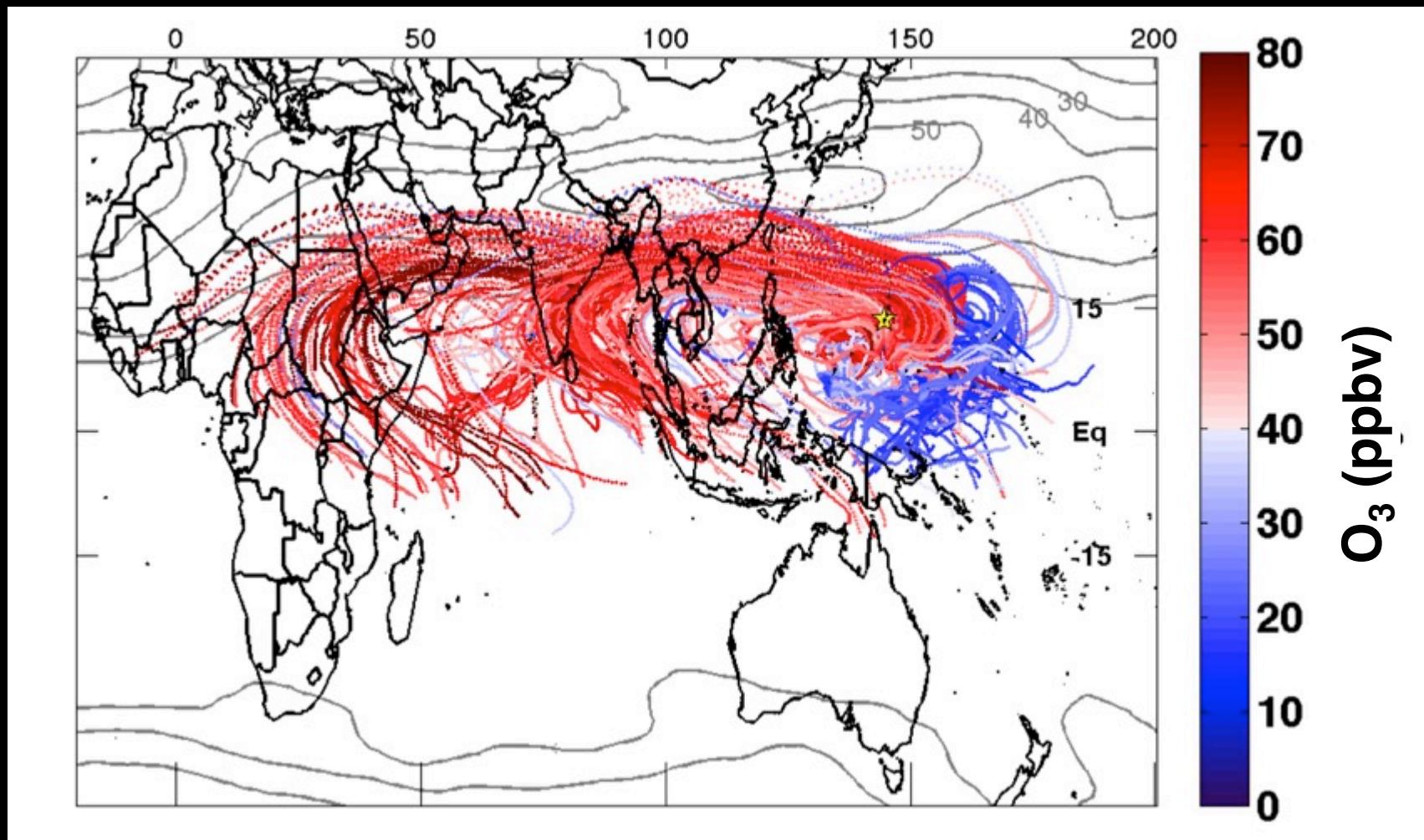
10-day kinematic back trajectories colored by observed O<sub>3</sub>. Contours are zonal winds at 200 hPa in m/s.



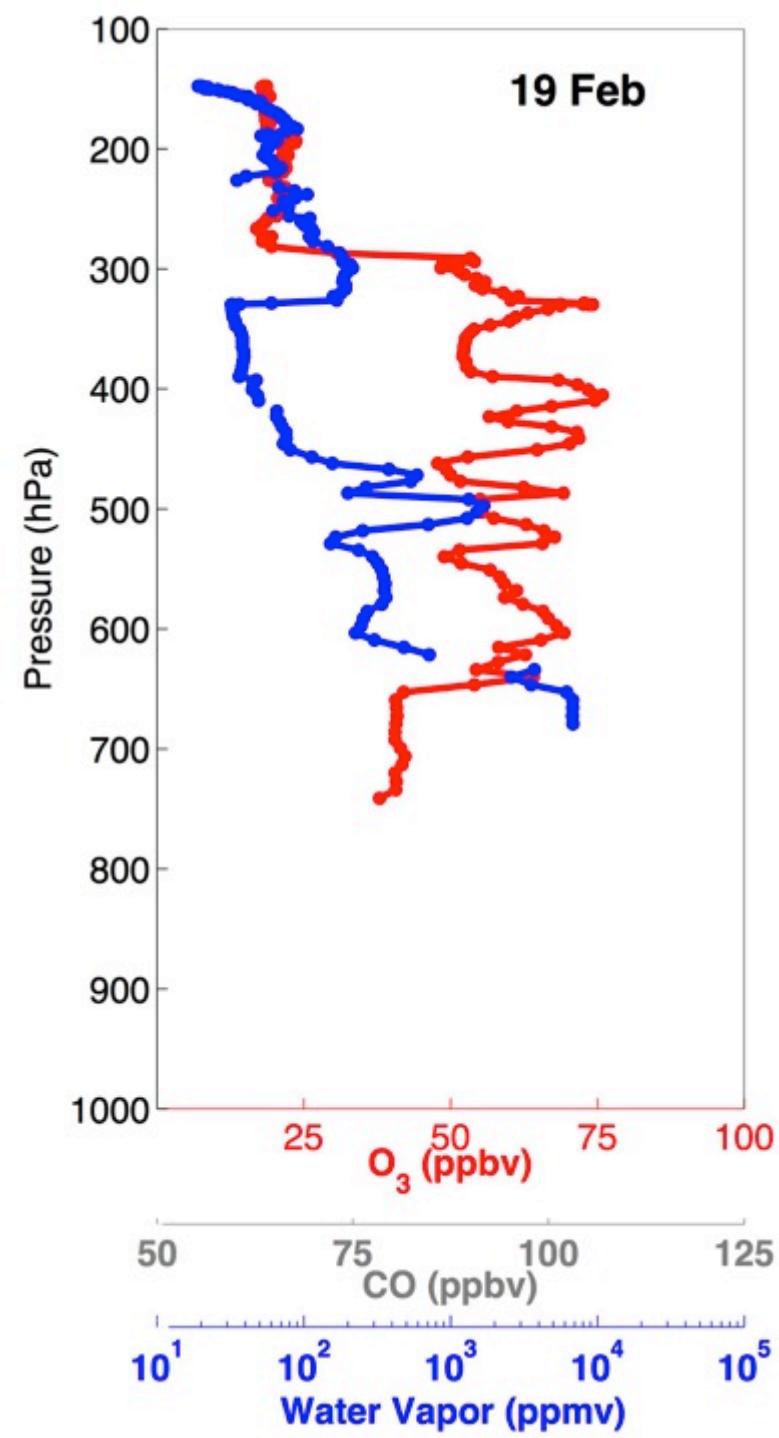
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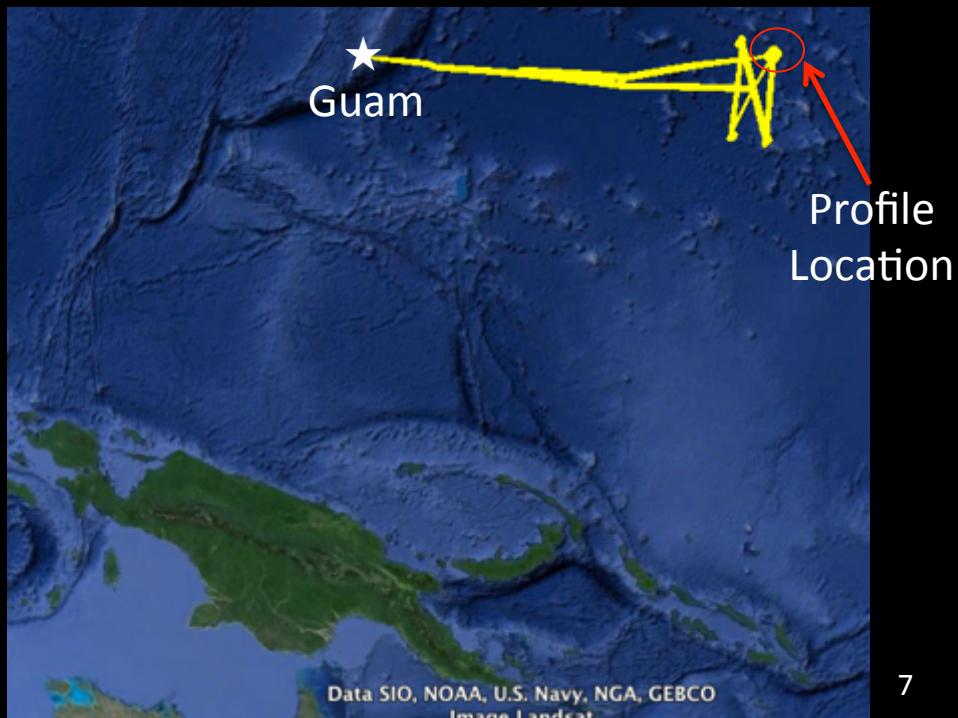
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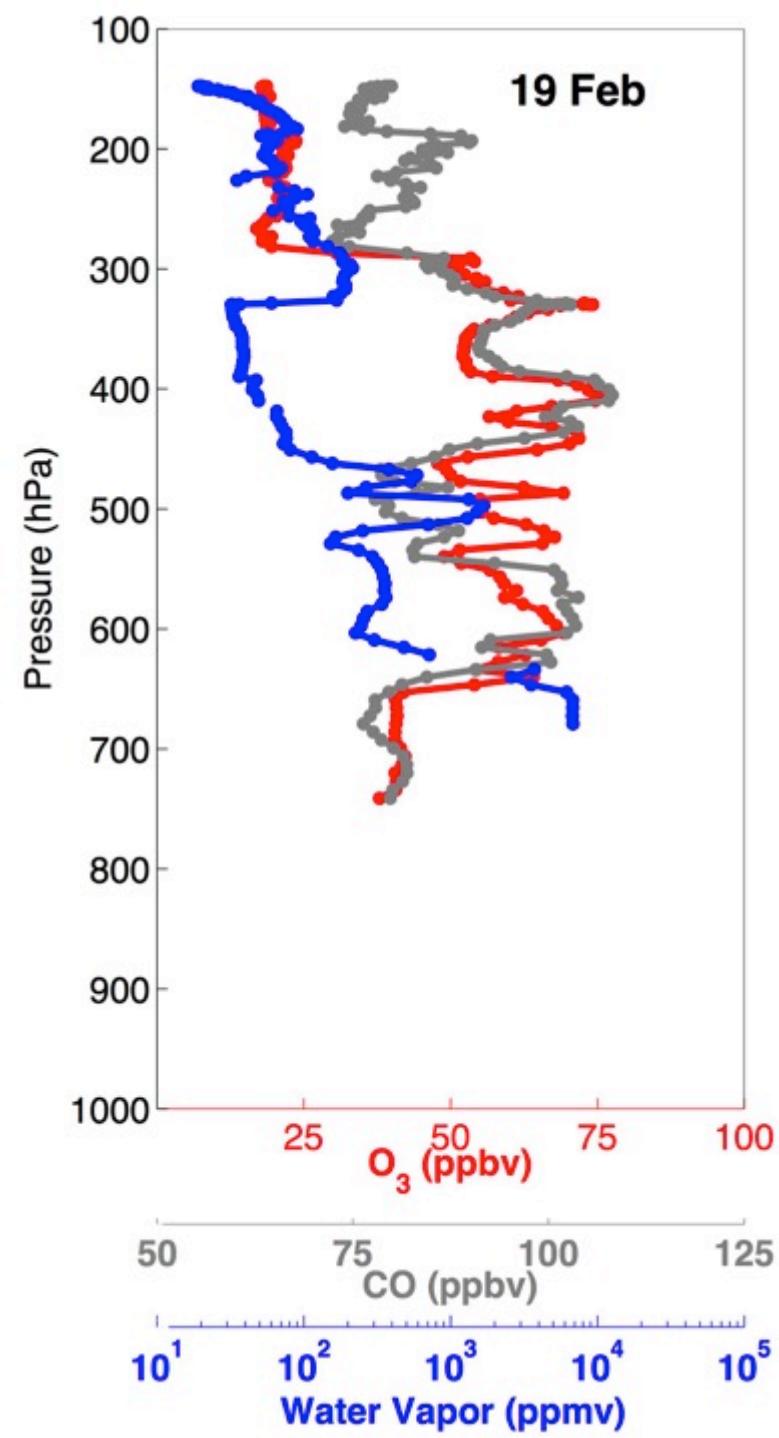


Stop trajectories at point of last precipitating convection.



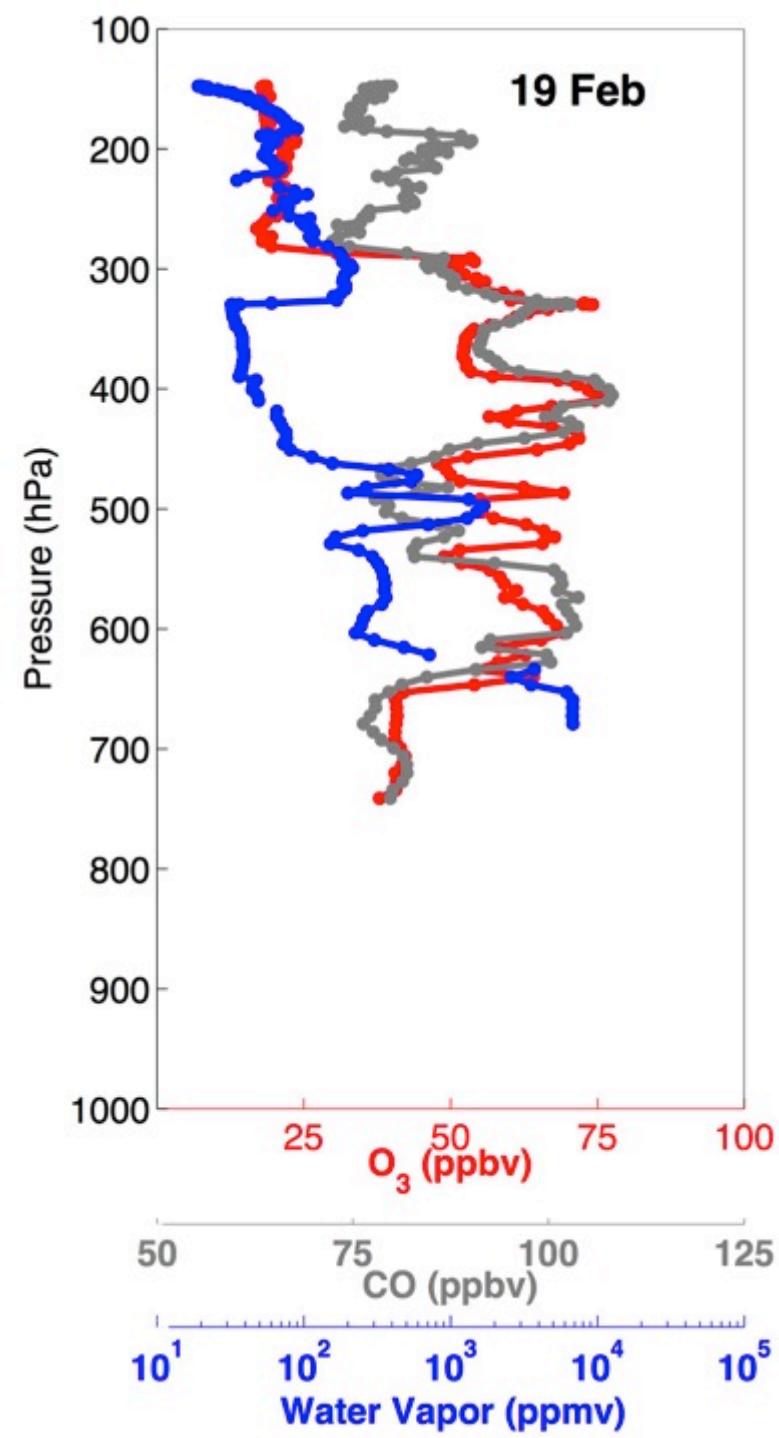
- Sample profile from CONTRAST RF13
- Previous studies attribute to:
  - Stratospheric intrusion
  - Transport from the mid-latitude upper troposphere



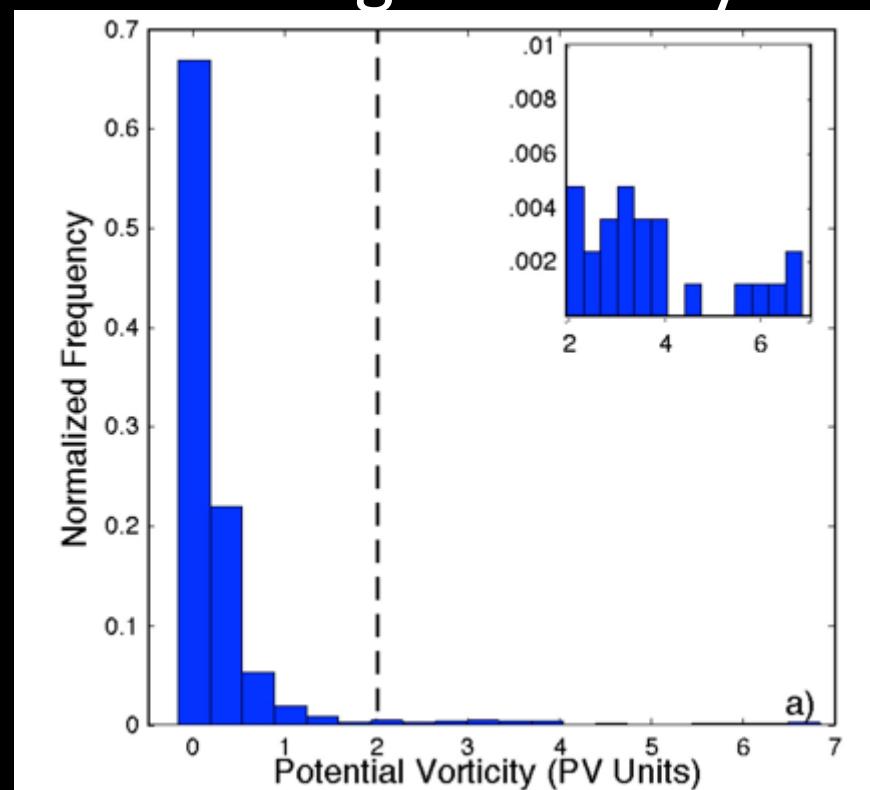


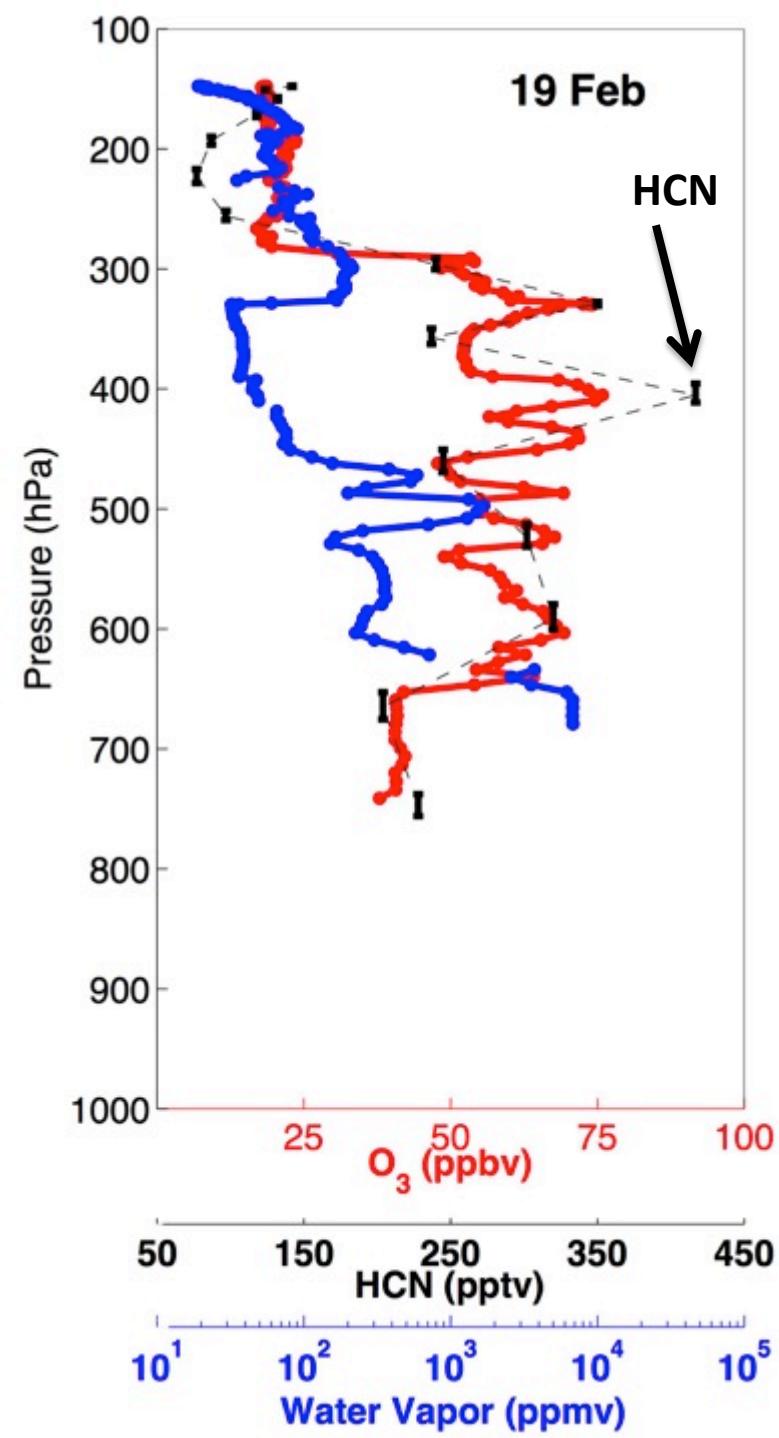
- $O_3$  tightly correlated with CO ( $r^2 = 0.61$  for whole campaign).





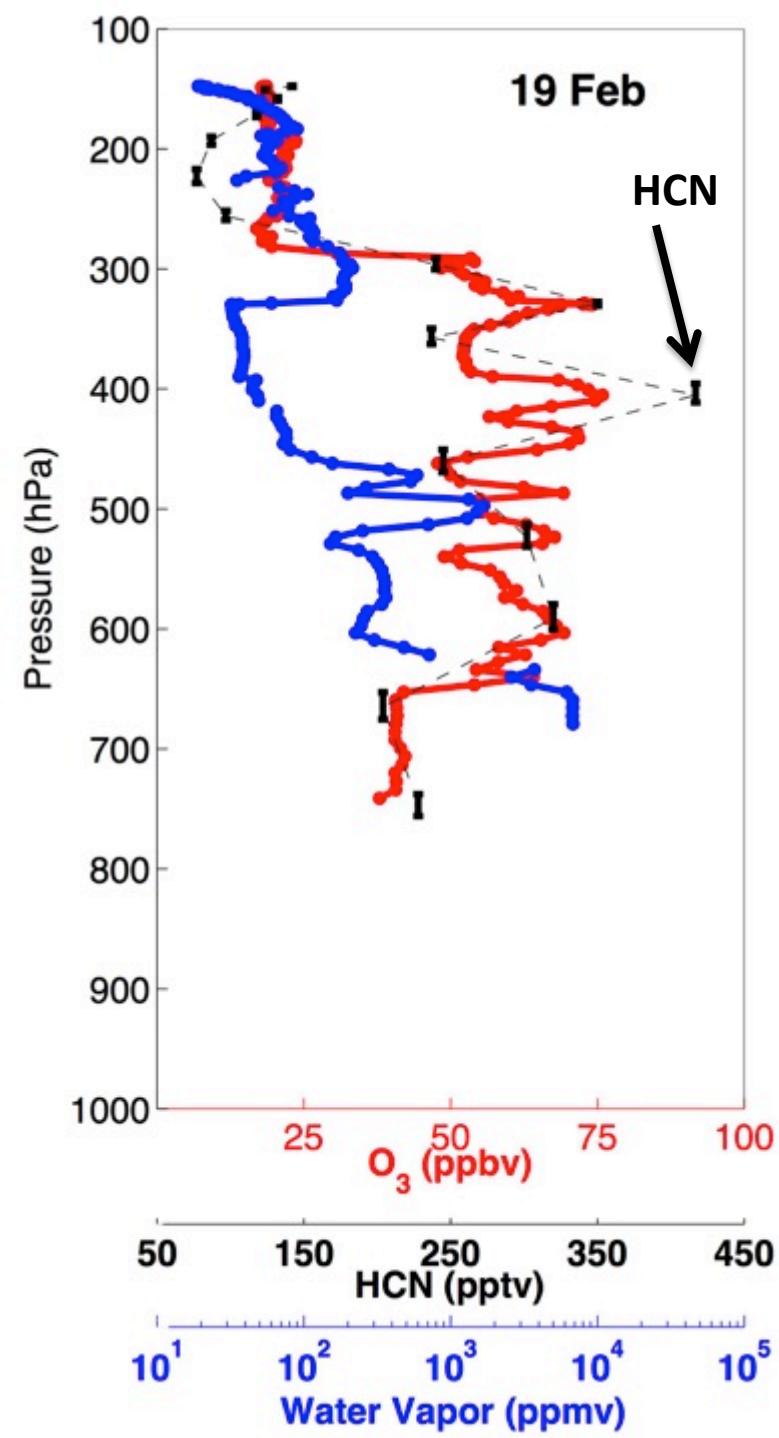
- $O_3$  tightly correlated with CO ( $r^2 = 0.61$  for whole campaign).
- Implies little stratospheric influence. Confirmed by PV and mixing line analyses.



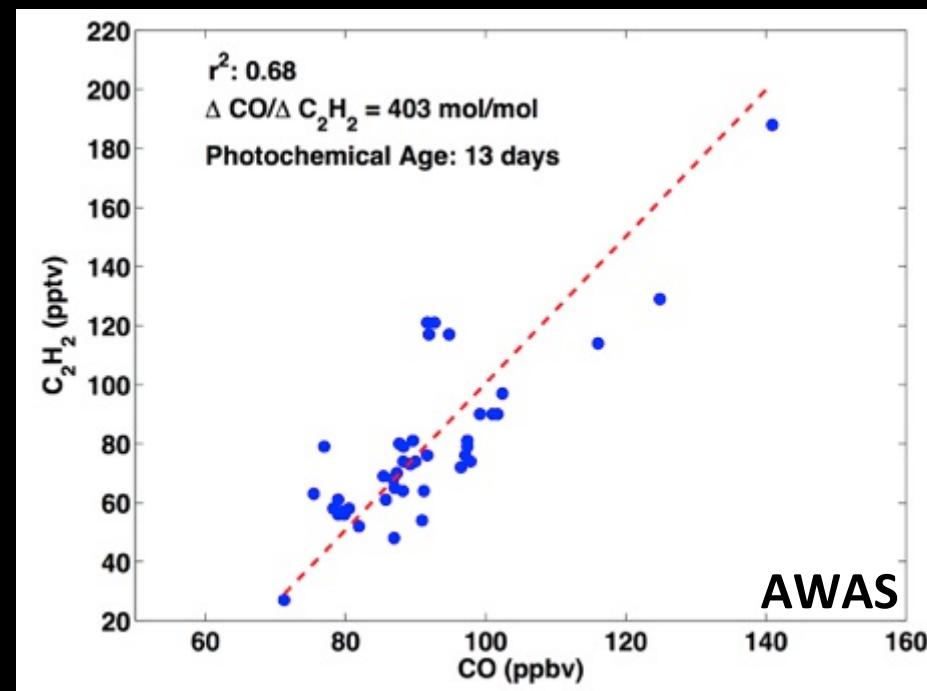


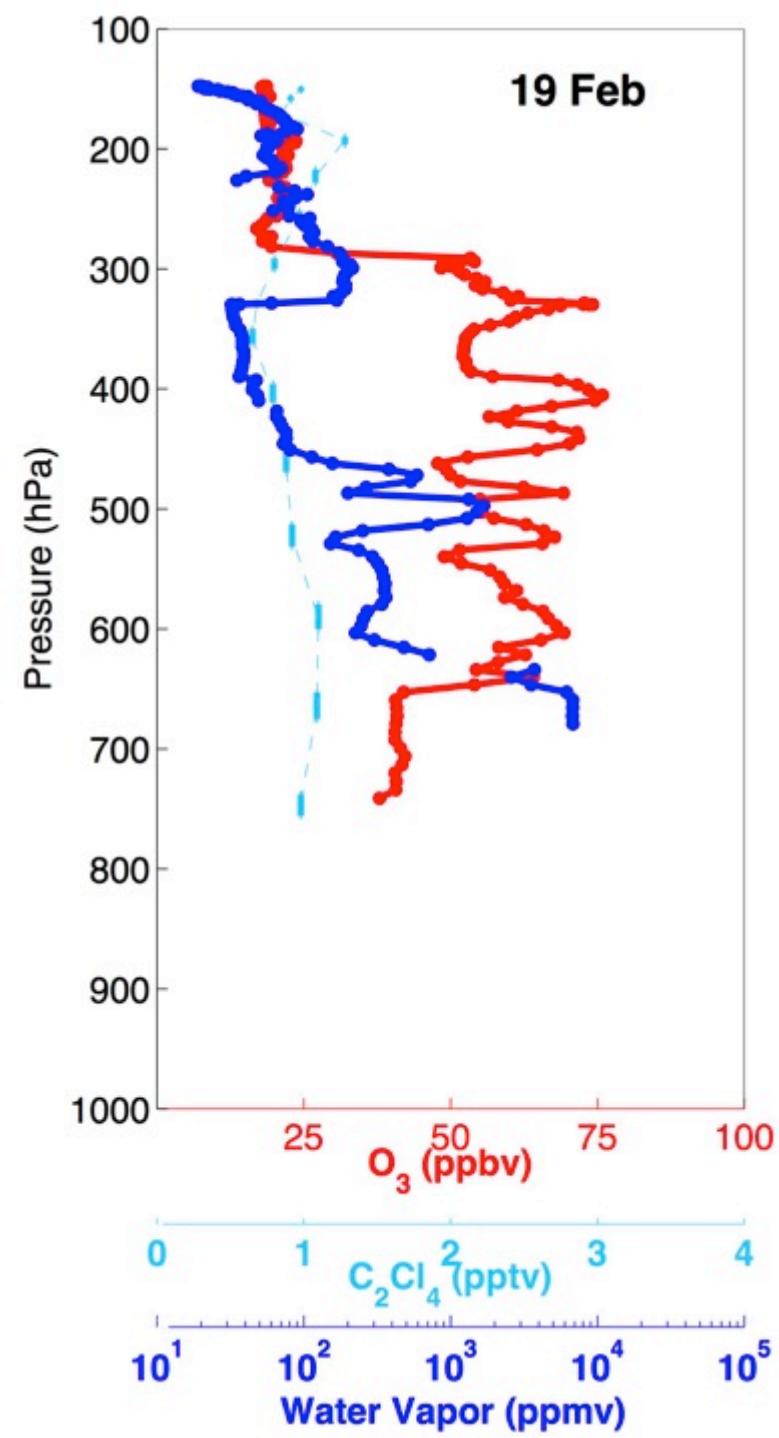
- Tight correlation between  $O_3$  and the biomass burning tracer HCN ( $r^2 = 0.80$  for whole campaign).



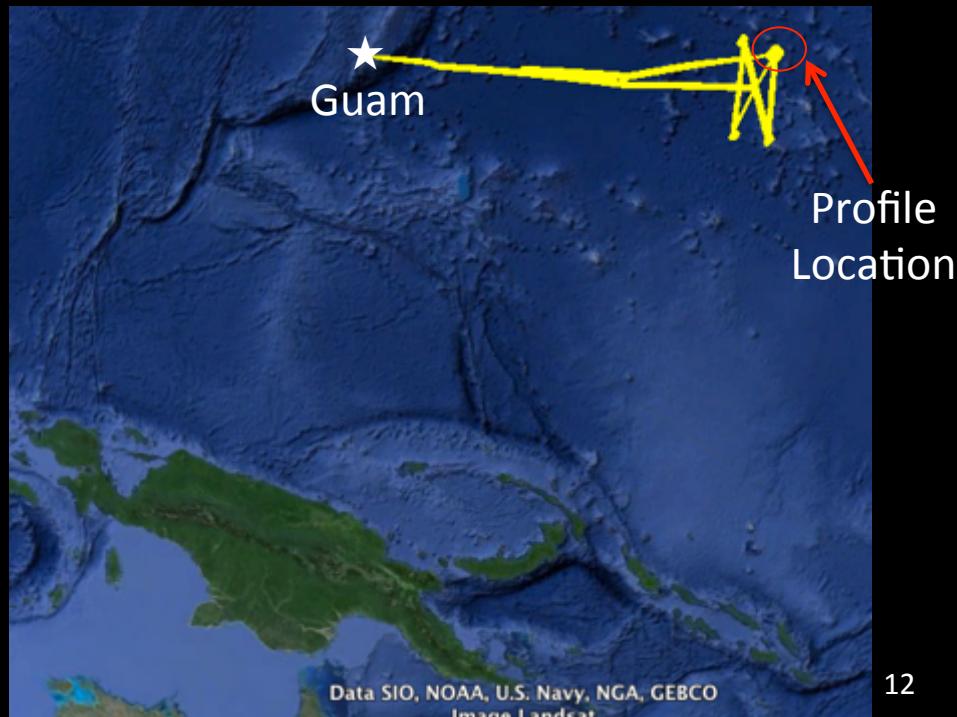


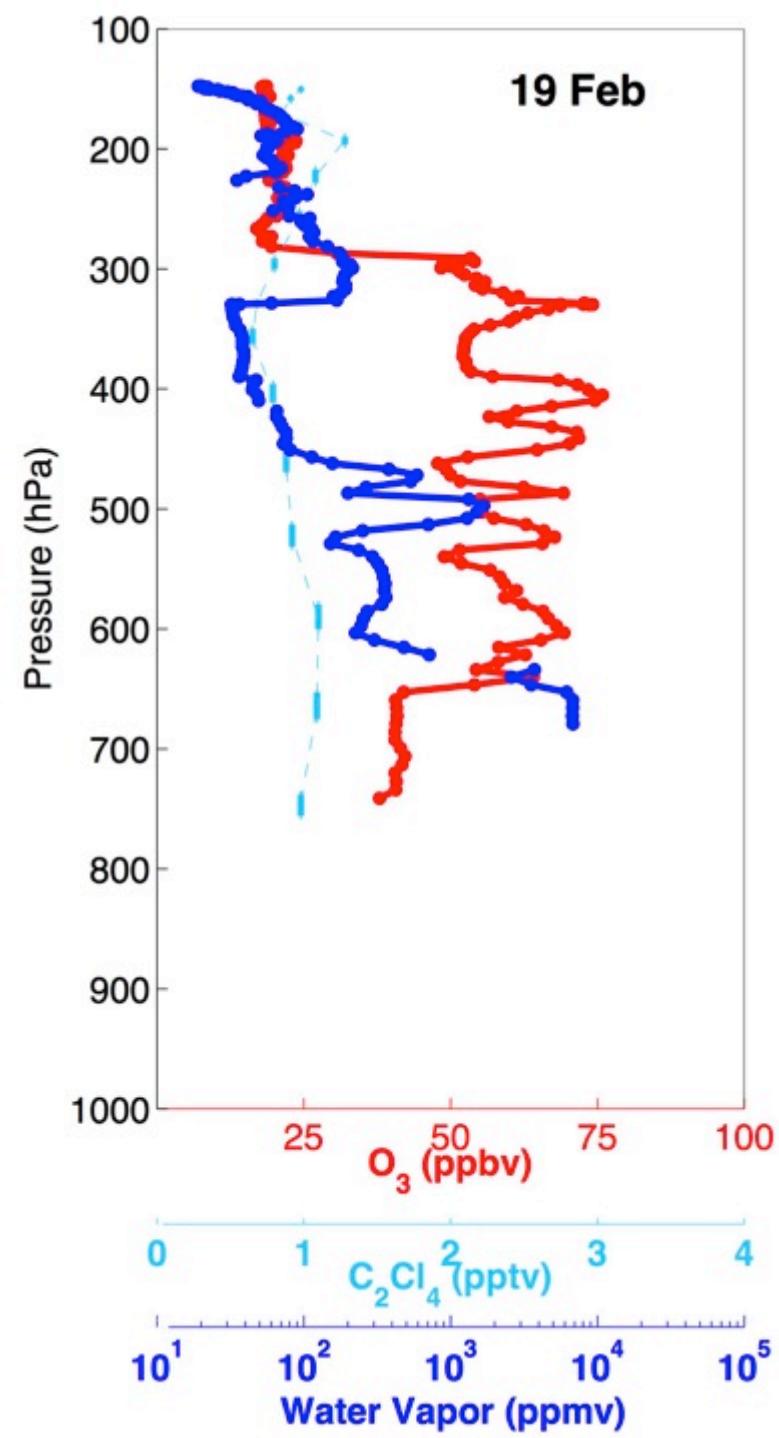
- Tight correlation between  $\text{O}_3$  and the biomass burning tracer HCN ( $r^2 = 0.80$  for whole campaign).
- CO correlates with  $\text{C}_6\text{H}_6$  and  $\text{C}_2\text{H}_2$  in filaments.



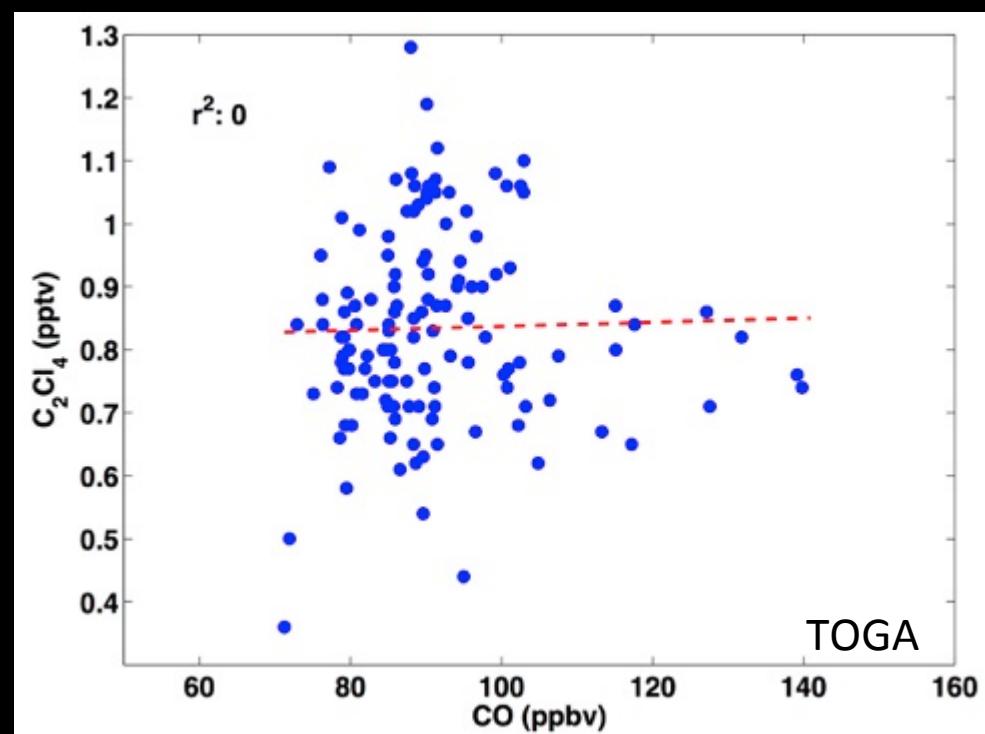


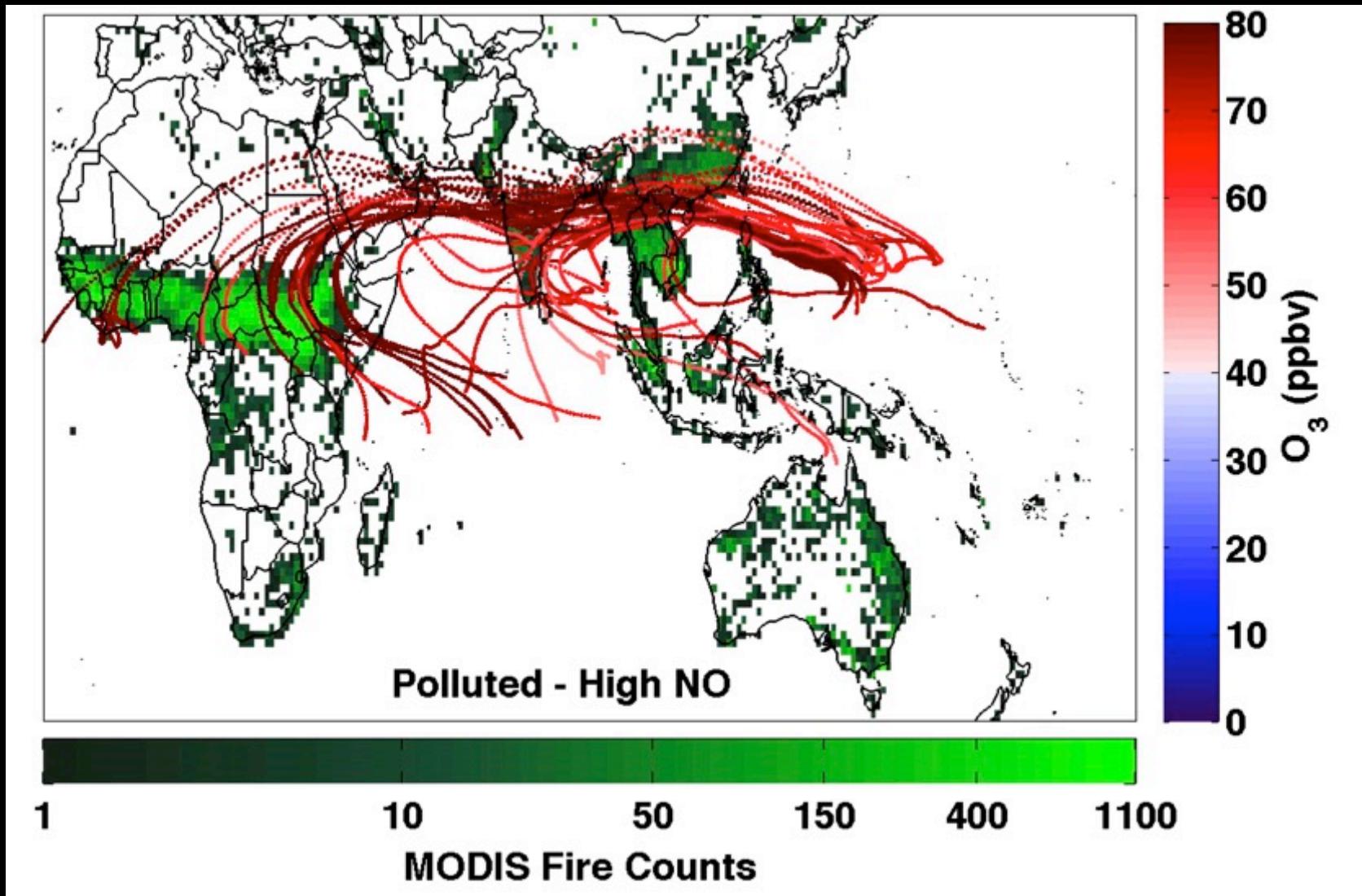
- Filaments depleted in  $C_2Cl_4$  when compared to background air.
- Limited mid-latitude influence.





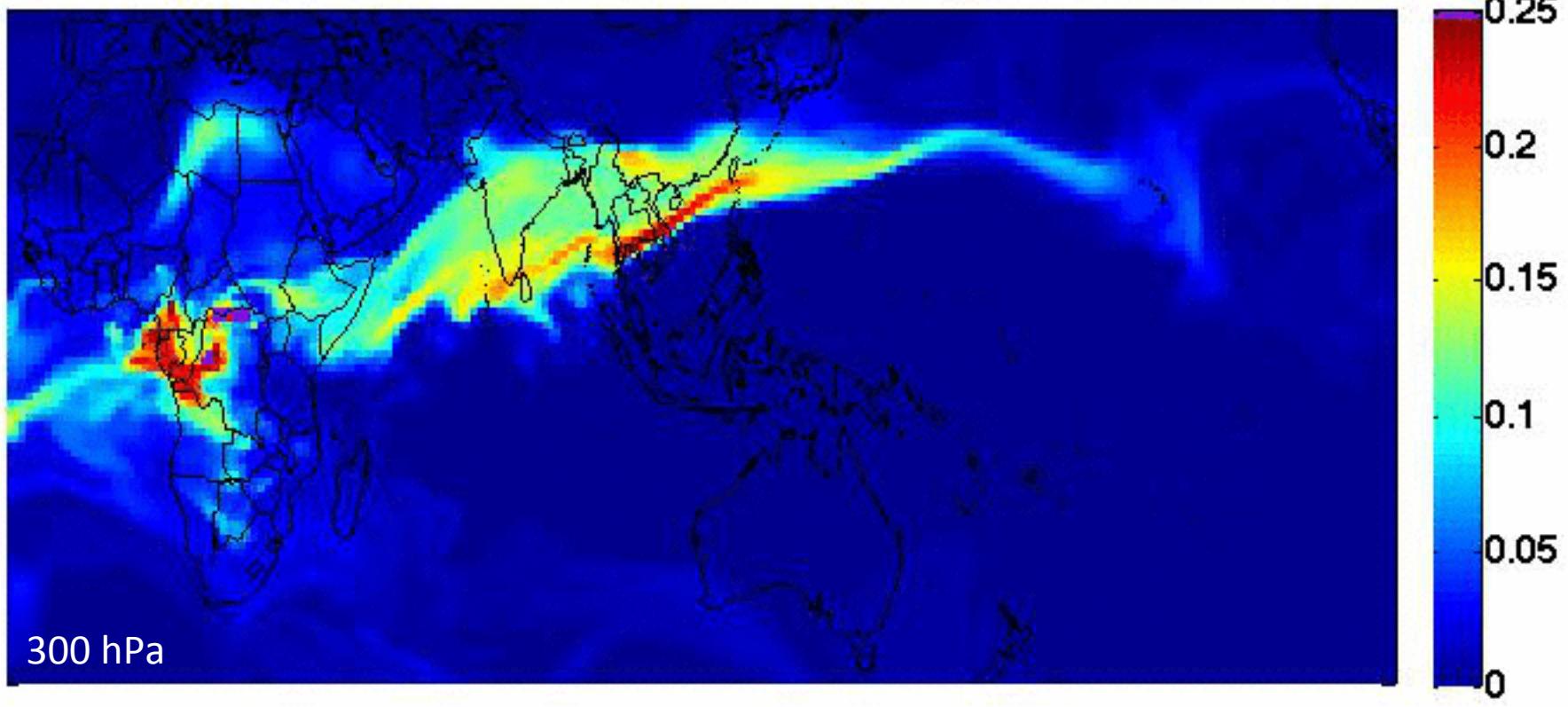
- Filaments depleted in C<sub>2</sub>Cl<sub>4</sub> when compared to background air.
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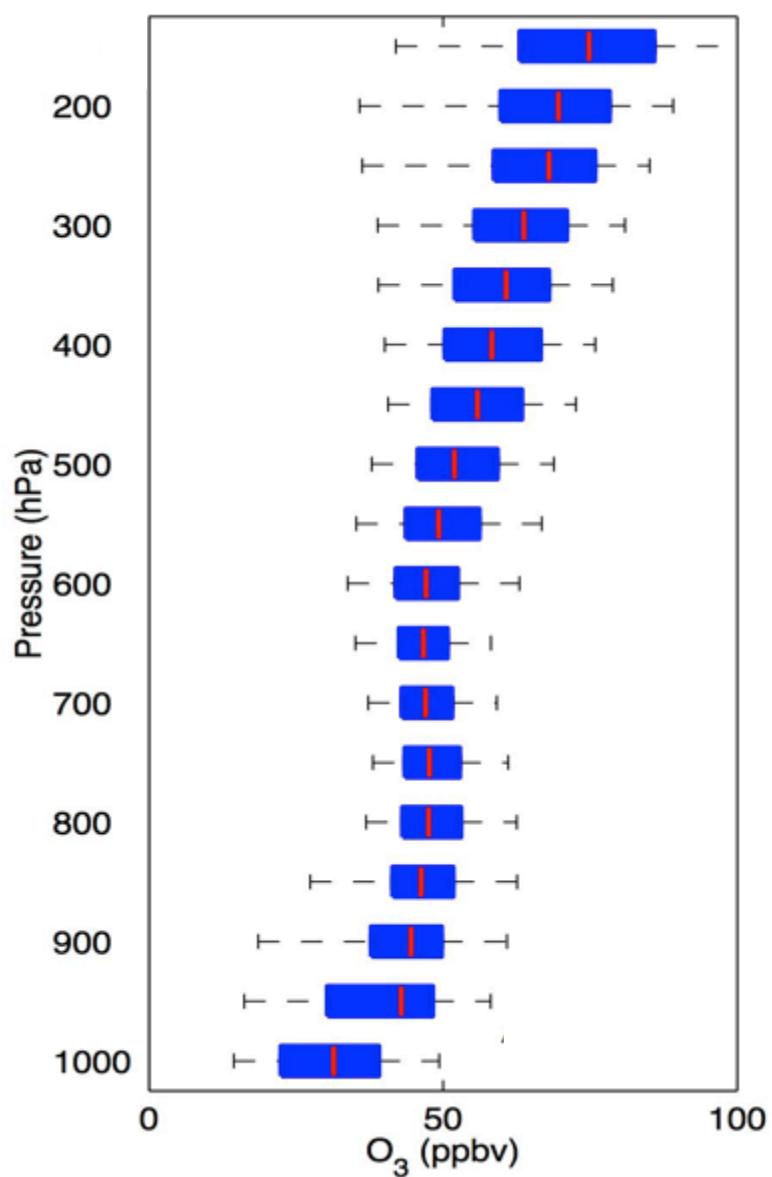
O<sub>3</sub> > 50 ppbv, CO > 95 ppbv

Fraction of African Biomass Burning CO (01 Feb 2014)

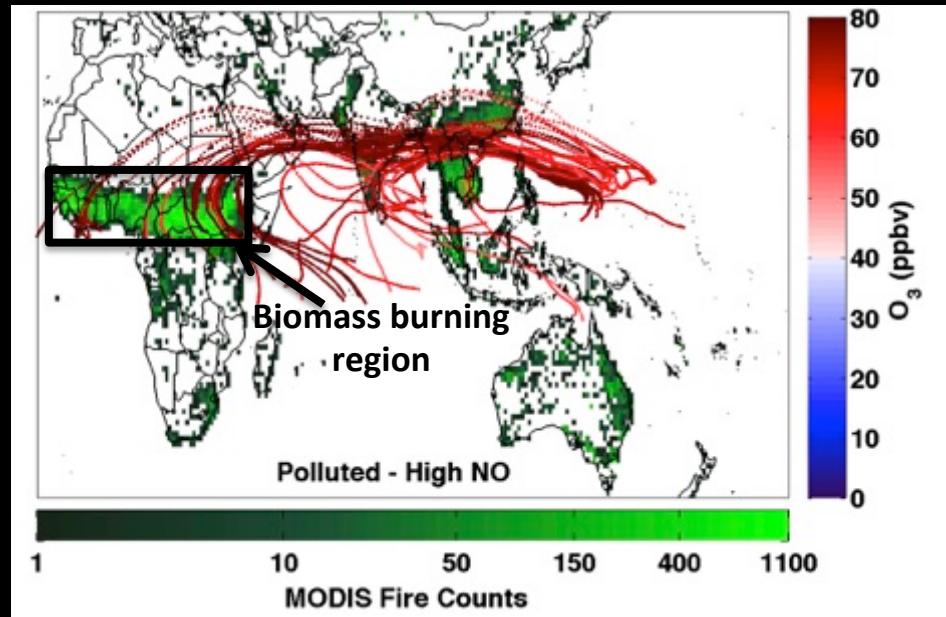


- Tagged African biomass burning CO in CAM-Chem
- African CO responsible for up to 20% of total CO in remote Pacific.

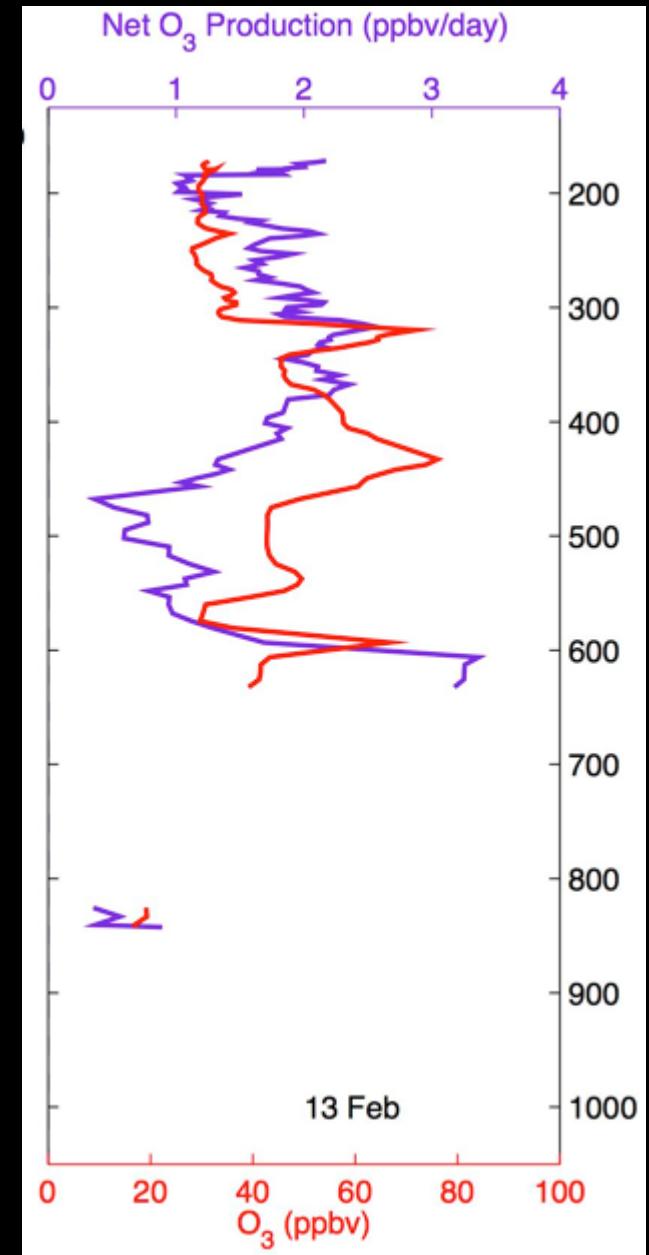
# CAM-Chem O<sub>3</sub> over the African Biomass Burning Region



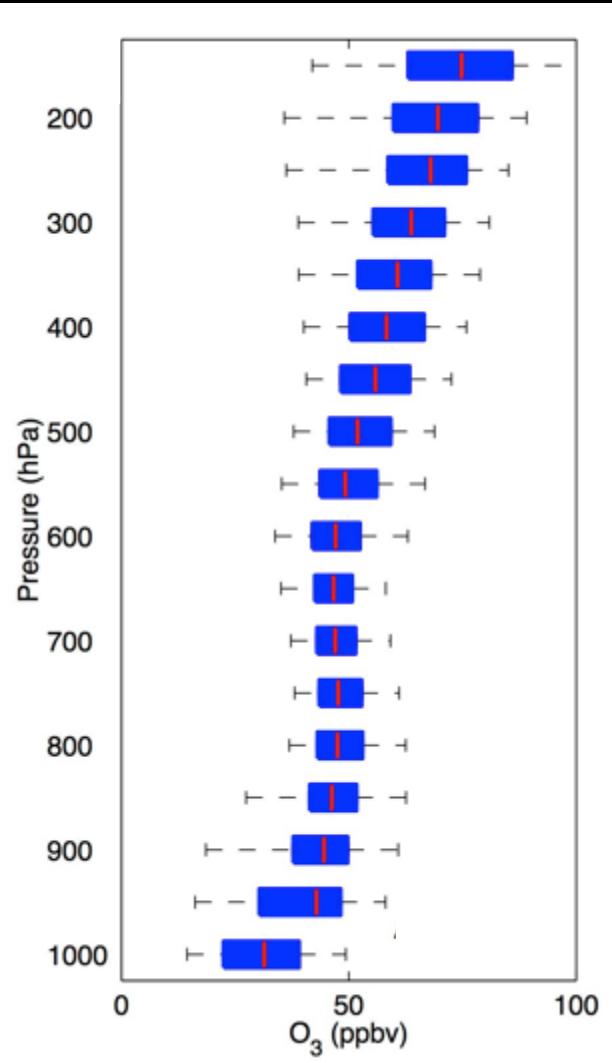
- Background O<sub>3</sub> over African biomass burning region ~50 ppbv.
- Agrees well with SHADOZ observations.



- Box-modeling shows  $\sim$ 2 ppbv/day of ozone production.
- Assuming constant production with time, can produce  $\sim$ 20 ppbv of  $O_3$  over 10 days.

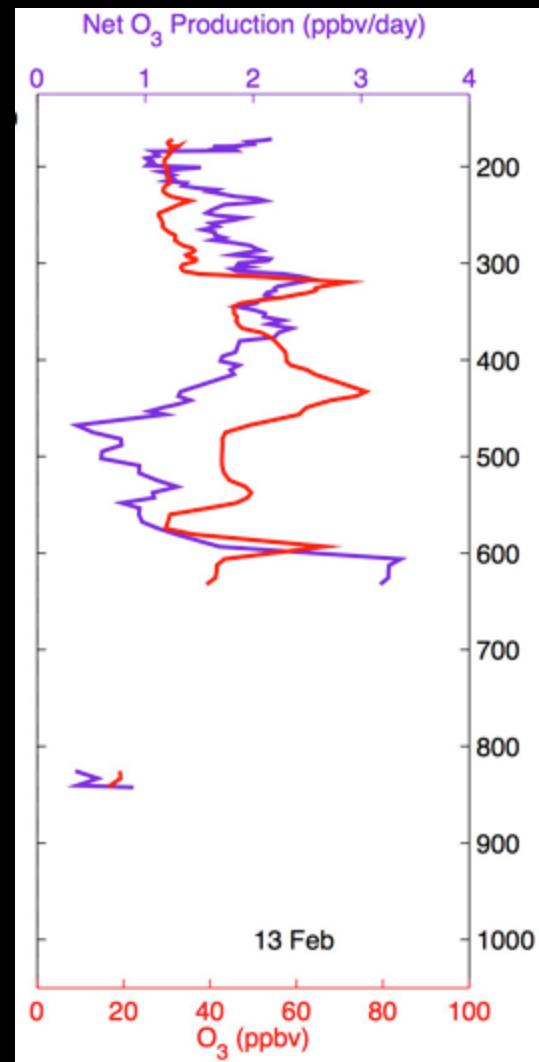


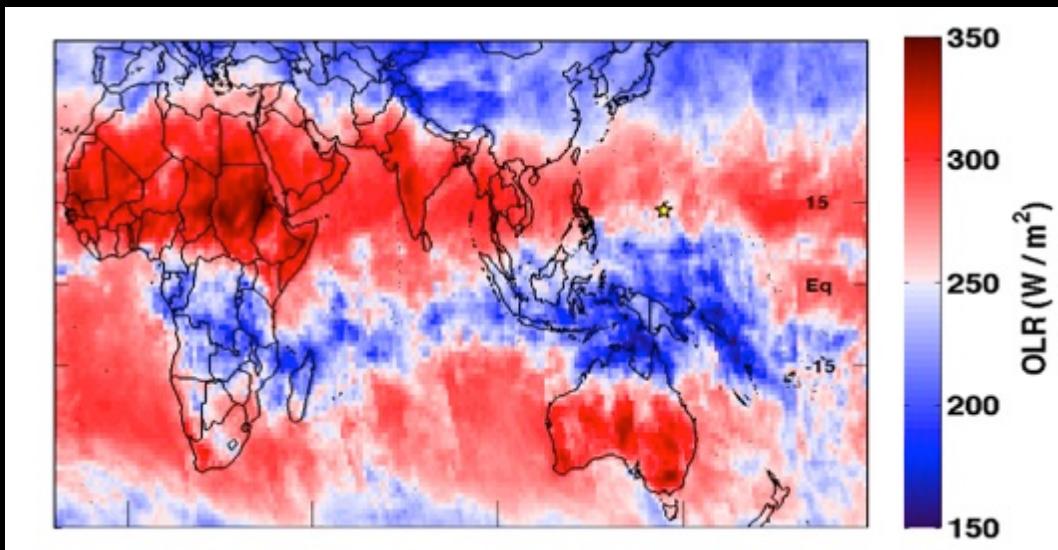
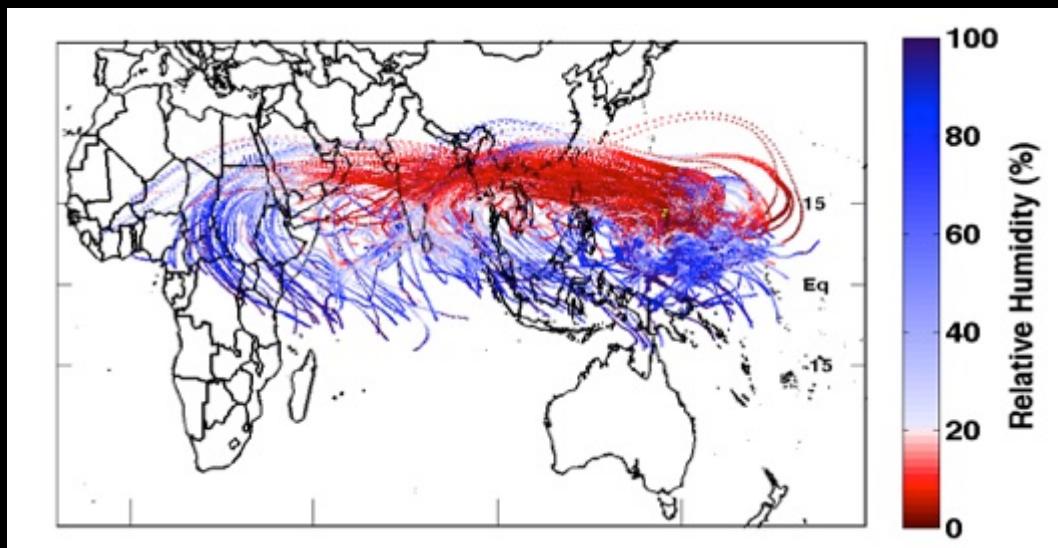
# CAM-Chem O<sub>3</sub> over the African Biomass Burning Region



Sum of  
background and  
photochemical  
production  
consistent with  
observed O<sub>3</sub>.

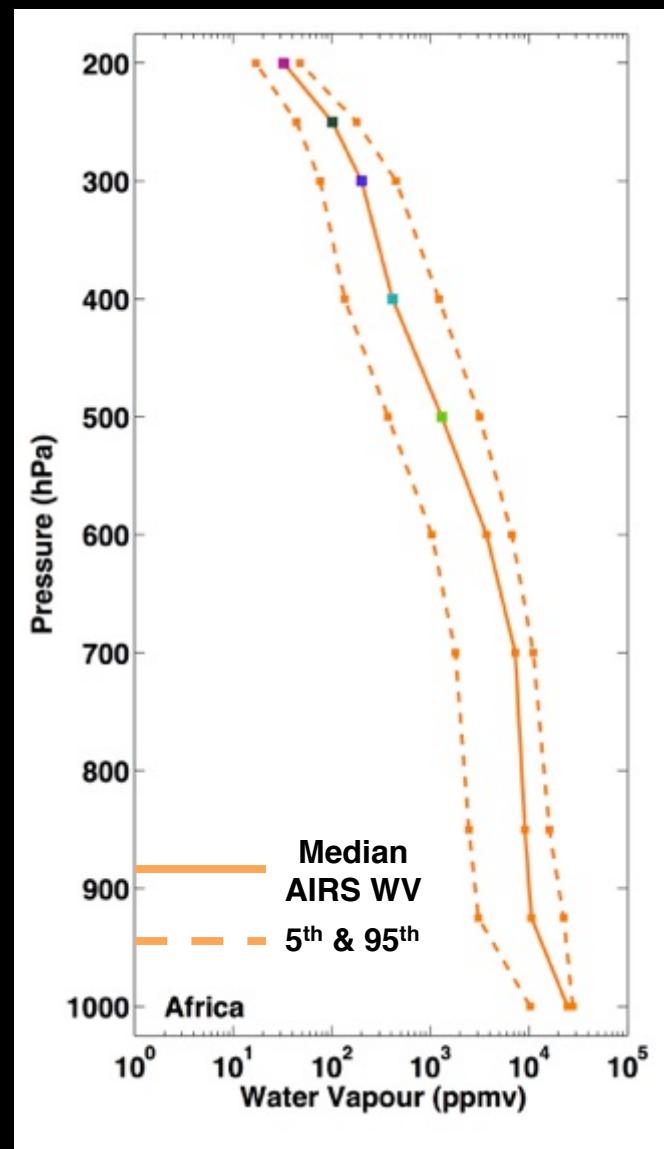
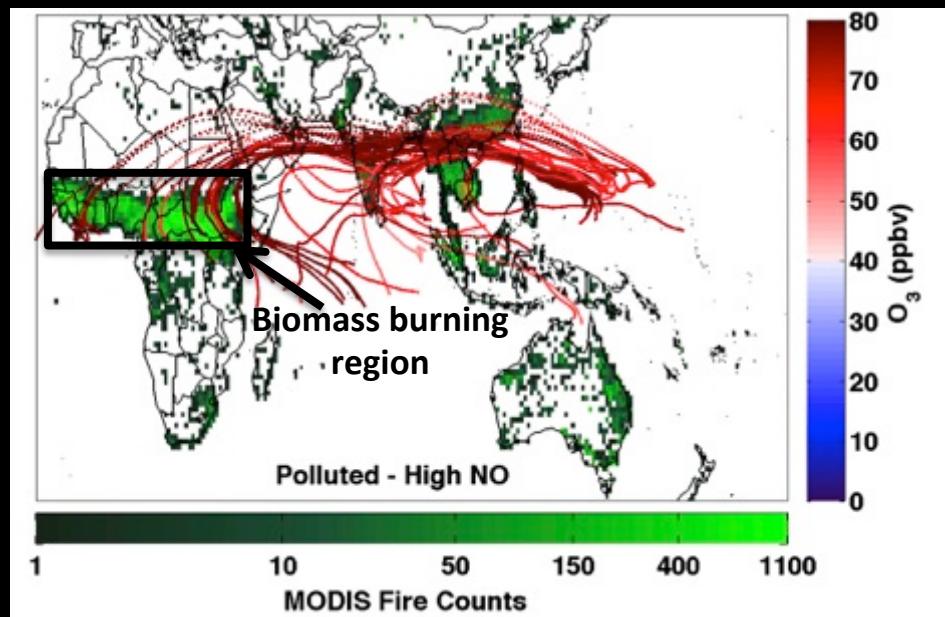
# Box-modeled Net O<sub>3</sub> Production



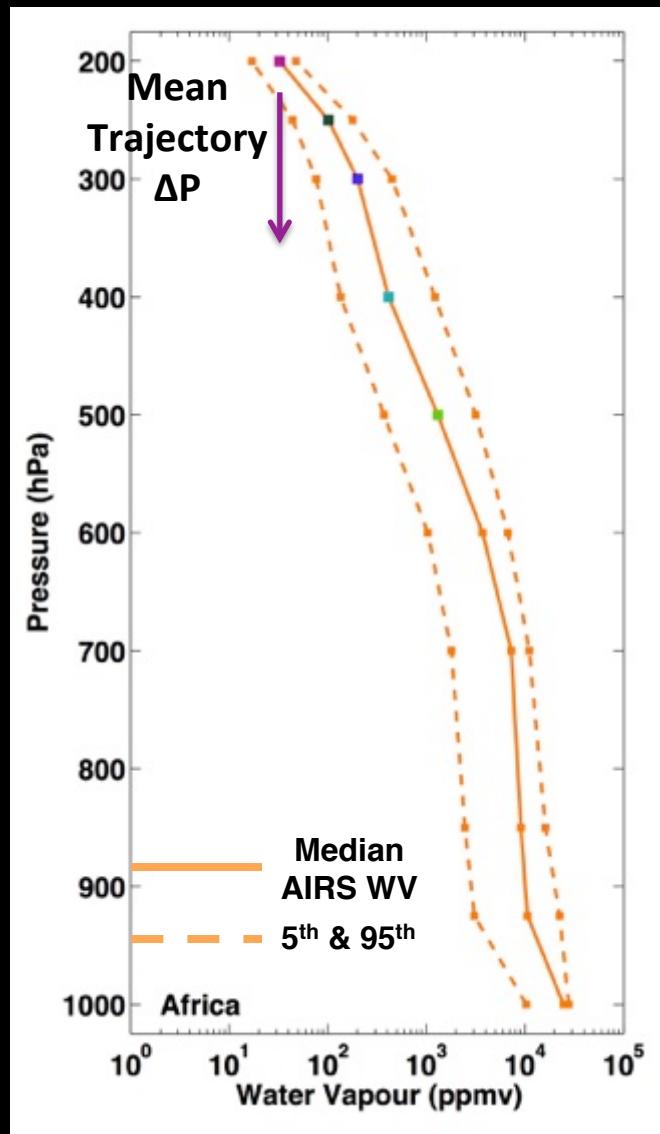
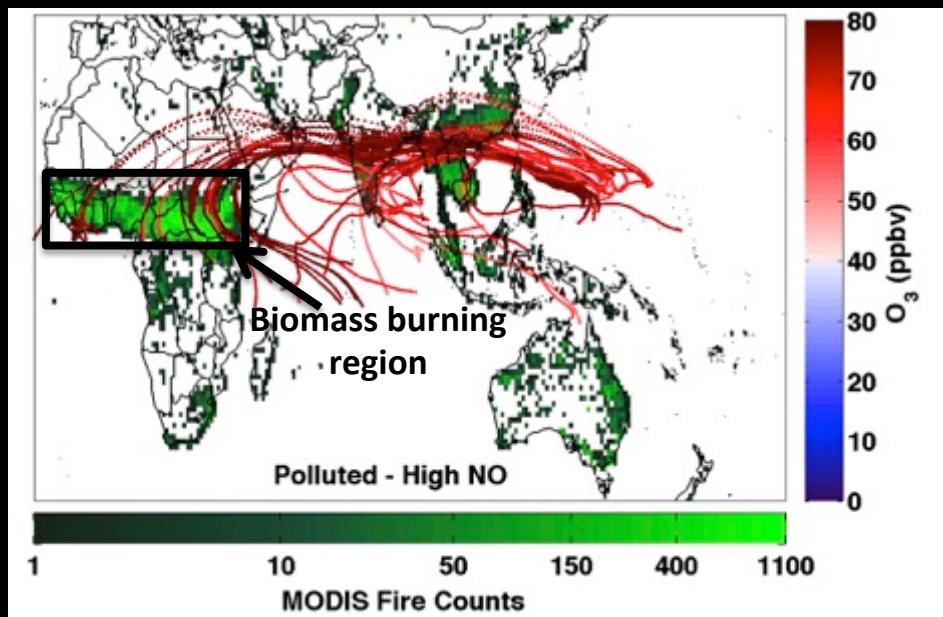


Low RH parcels originate in the ascending (blue) branch of Hadley Cell and reach Pacific in the descending branch (red).

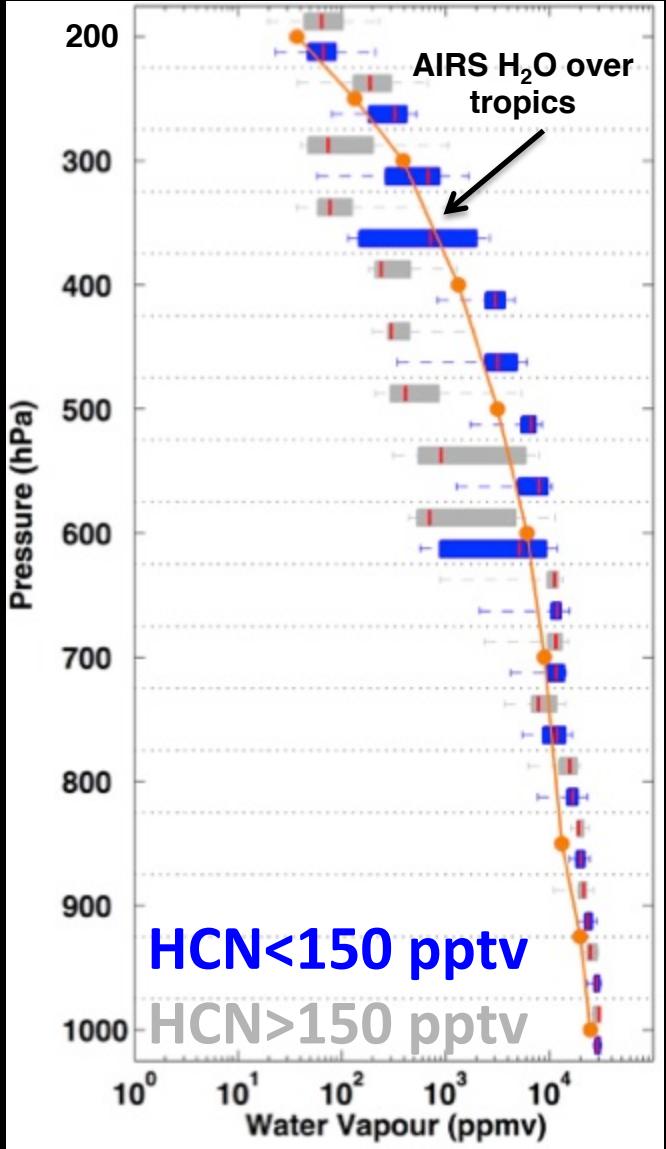
# AIRS H<sub>2</sub>O Over African Biomass Burning Region



# AIRS H<sub>2</sub>O Over African Biomass Burning Region

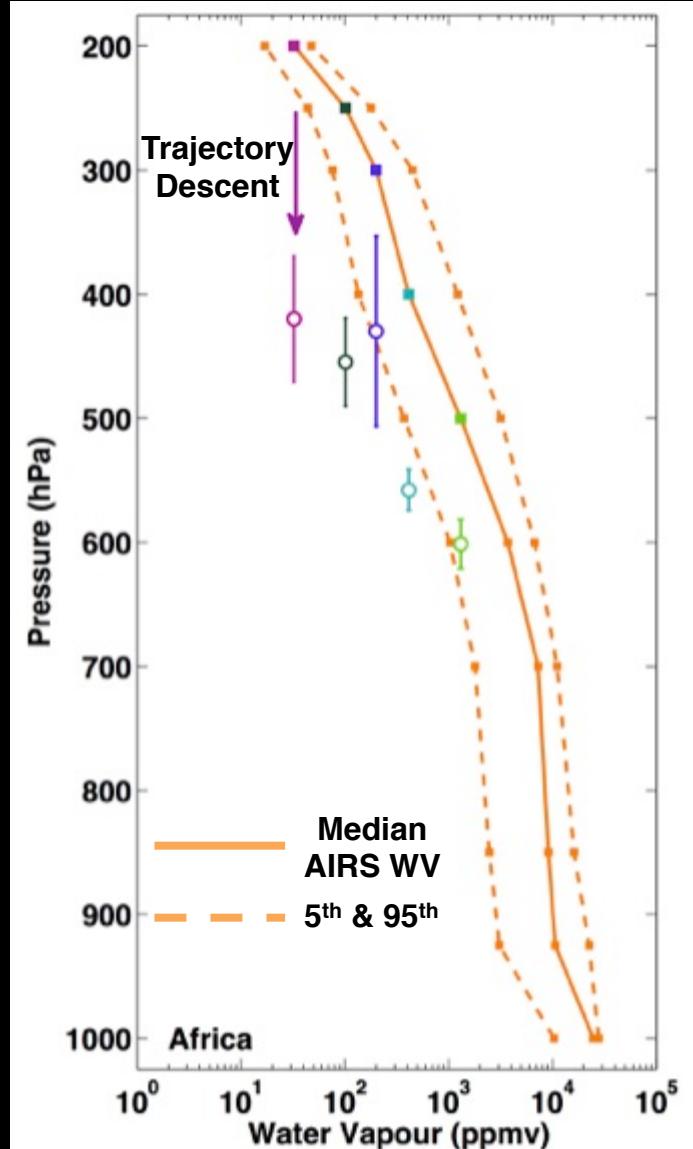


# Distribution of observed H<sub>2</sub>O

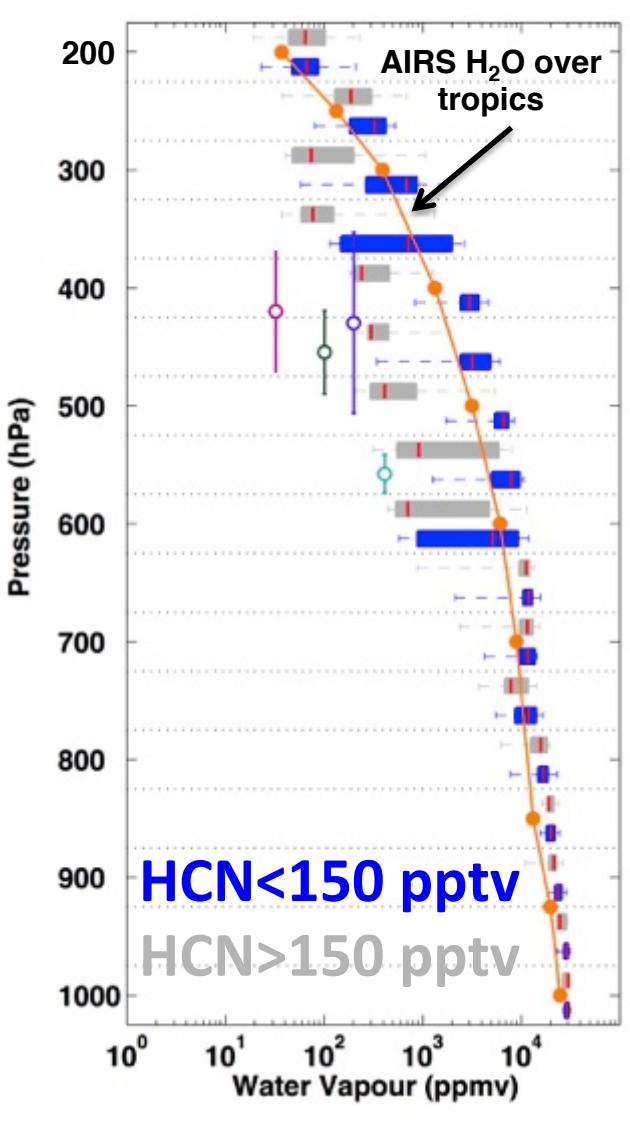


Descent of air parcels produces an H<sub>2</sub>O profile consistent with observations.

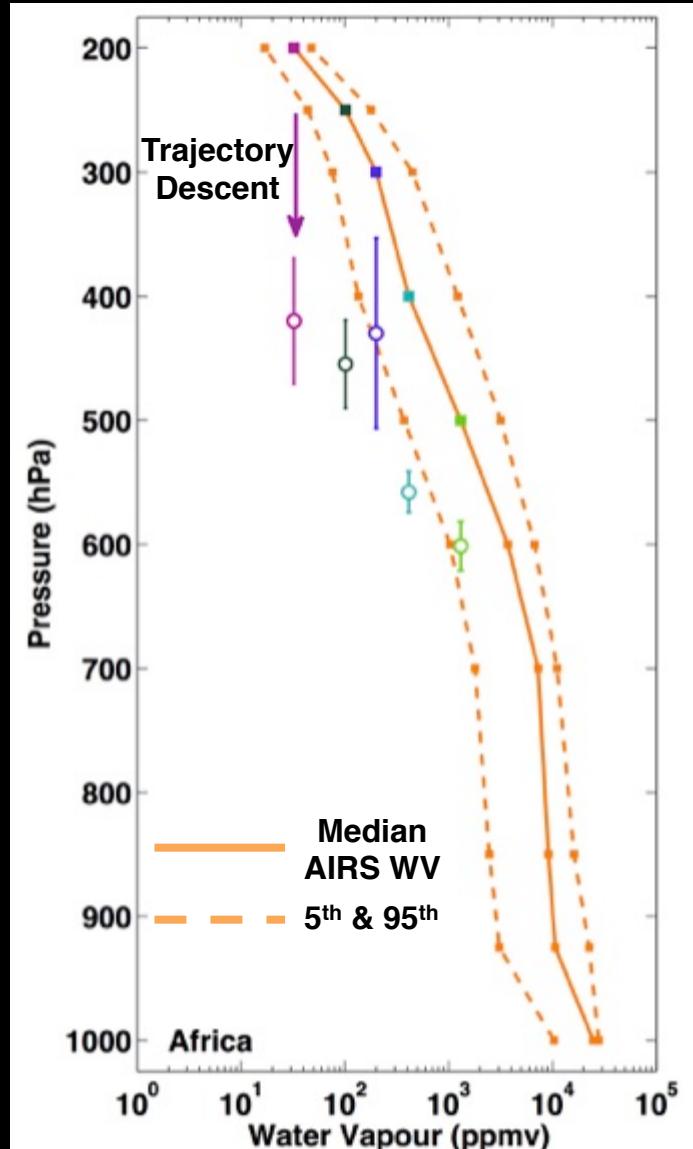
# AIRS H<sub>2</sub>O Over African Biomass Burning Region



# Distribution of observed H<sub>2</sub>O



# AIRS H<sub>2</sub>O Over African Biomass Burning Region



Descent of air  
parcels  
produces an  
H<sub>2</sub>O profile  
consistent  
with  
observations.

# Conclusions

- Biomass burning in the tropics dominant source of high O<sub>3</sub>.
- Low water vapor results from large-scale descent within the tropics.
- Implies that efforts to control the climatic impacts of O<sub>3</sub> should focus on emissions of O<sub>3</sub> precursors in the tropics.
- Anthropogenic activities could be affecting the oxidization capacity of the atmosphere in the tropical western Pacific.